

WE CLAIM:

1 1. A method for rapid tomographic measurement of
2 conductivity distribution in a sample, comprising the steps of:

3 (a) launching electrical excitation signals
4 simultaneously into a sample from a multiplicity of locations
5 distributed in said sample;

6 (b) measuring at a multiplicity of locations in said
7 sample at least one parameter selected from the group which
8 consists of potential difference and magnetic field strength
9 resulting from said electrical excitation signals; and

10 (c) correlating the measured potential differences or
11 magnetic field strengths with the launched excitation signals to
12 provide conductivity distribution cross section in said sample.

1 2. The method defined in claim 1 wherein the
2 electrical excitation signals are launched as orthogonal signals
3 into said sample.

1 3. The method defined in claim 2 wherein the
2 electrical excitation signals are launched as orthogonal
3 sinusoidal signals into said sample.

1 4. The method defined in claim 3 wherein in the
2 measurement of said parameter at least one voltage component a_1 ,
3 b_1 is determined using a defining equation of the Fourier-
4 analysis cosine coefficients according to the formula:

$$a_i = \frac{2}{T} \int_0^T U_G(t) \cos(i\omega_0 t) dt$$

5 where a_i = peak value of the measured voltage amplitude;
6 ω_0 = fundamental frequency of the excitation signal;
7 i = the index of the excitation signal from 1 to ∞ ;
8 $U_G(t)$ = measured potential difference; and
9 t = time
10 or
11 using a defining equation

12 of the Fourier-analysis sine coefficients according to the
 13 formula:

$$b_i = \frac{2}{T} \int_0^T U_G(t) \sin(i\omega_0 t) dt$$

14 where b_i = peak value of the measured voltage amplitude phase
 15 shifted by 90° ;
 16 ω_0 = fundamental frequency of the excitation signal;
 17 i = the index of the excitation signal from 1 to ∞ ;
 18 $U_G(t)$ = measured potential difference; and
 19 t = time.

1 5. The method defined in claim 4 wherein the
 2 coefficients a_i , b_i are used to calculate a complex impedance of
 3 the sample.

1 6. The method defined in claim 1 wherein the
2 excitation signals launched into said sample are coded signals.

1 7. The method defined in claim 1 wherein the
2 excitation signals launched into said sample can assume either of
3 only two possible amplitudes.

1 8. The method defined in claim 1 wherein at least
2 three electrodes in spaced apart relationship are inserted into
3 said sample for launching said excitation signals into said
4 sample.

1 9. The method defined in claim 1 wherein at least two
2 electrodes in spaced apart relationship are inserted into said
3 sample for measuring potential differences therein.

1 10. The method defined in claim 1 wherein at least
2 three electrodes in spaced apart relationship are inserted into

3 said sample for launching said excitation signals into said
4 sample and at least two electrodes in spaced apart relationship
5 are inserted into said sample for measuring potential differences
6 therein, said electrical excitation signals are applied to said
7 sample at at least a part of the three electrodes so that a
8 potential distribution occurs in the sample and potential
9 differences are measured at said at least two electrodes.

1 11. The method defined in claim 10 wherein said
2 electrical excitation signals are applied simultaneously to said
3 at least three electrodes and the measured potential differences
4 are correlated proportionally with supplied electrical
5 excitation signals.

1 12. The method defined in claim 1 wherein the
2 electrical excitation signals are launched into said sample from
3 the same electrodes with which measurements of the potential
4 differences are made.

1 13. The method defined in claim 1 wherein said
2 electrodes are spikes driven into the sample and having
3 electrically decoupled surfaces for applying said electrical
4 excitation signals to said sample and measuring potential
5 differences therein.

1 14. The method defined in claim 1 wherein said
2 electrical excitation signals are applied with a high-ohmic
3 current source.

1 15. The method defined in claim 1, further comprising
2 exciting said sample by energizing two coils in contact with said
3 sample.

1 16. The method defined in claim 1 wherein a magnetic
2 field strength is measured by a magnetic field sensor brought
3 into contact with said sample.

1 17. The method defined in claim 1 wherein the
2 electrical excitation signals are applied to at least part of a
3 plurality of excitation coils or excitation electrodes in contact
4 with the sample and as a result of conductivity distribution
5 therein a current density distribution and consequent magnetic
6 field strength distribution are effected in the sample.

7 18. The method defined in claim 1 wherein the
8 electrical excitation signals are applied to at least part of a
9 plurality of excitation coils or excitation electrodes in contact
10 with the sample and a correlation is made between a measured
11 field strength distribution in proportion to the electrical
12 excitation signals supplied.

1 19. The method defined in claim 1 wherein at least two
2 of said electrodes for measuring potential difference and at
3 least one magnetic field sensor for measuring a magnetic field
4 strength are provided in said sample.

1 20. The method defined in claim 1 wherein at least
2 three electrodes for applying an electrical excitation to said
3 sample and at least one magnetic field sensor for measuring a
4 magnetic field strength are provided in contact with said sample.

1 21. The method defined in claim 1 wherein said
2 electrical excitation signals are formed by an alternating
3 current fed to said sample.

1 22. The method defined in claim 1 wherein electrical
2 excitation signals in the form of an alternating voltage are fed
3 to the sample and the current amplitude in a conductor feeding
4 said electrical excitation signals to the sample is measured.;

5 23. An apparatus for the rapid tomographic measurement
6 of a conductivity distribution in a sample, comprising:
7 an electrical excitation source coupled with said
8 sample for applying electrical excitation signals thereto;

9 at least one device coupled with said sample for
10 measuring a potential difference or magnetic field strength
11 therein in proportion to the electrical excitation signals
12 supplied thereto; and

13 circuitry for correlating a measured potential
14 difference or magnetic field strength proportionally with the
15 supplied electrical excitation signals.

1 24. The apparatus defined in claim 23 wherein said
2 circuitry includes a control and computing unit which produces
3 electrical orthogonal excitation signals and enabled a
4 correlation of measured potential differences or magnetic field
5 strengths proportionally with the electrical orthogonal
6 excitation signals.

1 25. The apparatus defined in claim 24 wherein said
2 control and computing unit comprises at least two generators for
3 producing orthogonal electrical excitation signals.

1 26. The apparatus defined in claim 25, further
2 comprising conductors for supplying said electrical excitation
3 signals to the sample.

1 27. The apparatus defined in claim 26 wherein said
2 circuitry includes an evaluation unit for calculating a
3 conductivity distribution in said sample.

1 28. The apparatus defined in claim 27 wherein the
2 electrical excitation source comprises at least three electrodes
3 engaged in said sample and in spaced-apart relationship.

1 29. The apparatus defined in claim 28 wherein said at
2 least one device comprises at least two electrodes in said sample
3 for measuring electromagnetic fields therein.

1 30. The apparatus defined in claim 23 wherein the
2 electrical excitation source comprises at least three electrodes

3 engaged in said sample and in spaced-apart relationship, said
4 electrodes being so configured as to enable a potential
5 difference measurement between said electrodes.

1 31. The apparatus defined in claim 30 wherein said
2 electrodes are in the form of spikes having excitation electrode
3 surfaces electrically decoupled from potential measuring surfaces
4 respectively along jackets and tips of the respective electrodes.

1 32. The apparatus defined in claim 23 wherein said
2 source includes at least two coils as the exclusive source of
3 excitation signals or in conjunction with excitation electrodes.

1 33. The apparatus defined in claim 23 wherein said
2 device includes at least one magnetic field sensor as the
3 exclusive means for measuring magnetic field strength or in
4 conjunction with at least one electrode.

1 34. The apparatus defined in claim 23 wherein said
2 circuitry includes a separating stage which decomposes the
3 measured signals in proportion to the applied electrical
4 excitation signals.